

FORAGING OF *STENOPOGON INQUINATUS* (LOEW) (DIPTERA: ASILIDAE) ON MONTANA RANGELAND SITES

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Abstract.—The robber fly *Stenopogon inquinatus* Loew preyed upon a wide variety of insects at rangeland sites in Montana. As is typical of *Stenopogon*, prey use varied with local insect abundance. *Stenopogon inquinatus* tended to take alate male *Formica subpolita* Mayr near ant mating swarms, honey bees (*Apis mellifera* L.) near flowers, and dung beetles (Scarabaeidae) on open range. These three groups, and other robber flies, comprised 90% of the prey records for *S. inquinatus*.

Key Words.—Insecta, Diptera, Asilidae, *Stenopogon*, foraging, prey

Stenopogon is a wide-ranging genus of robber flies in western North America, where more than 50 species occur (Wilcox 1971). Several studies of the behavior and ecology of *Stenopogon* have been undertaken (Cole 1958, Powell & Stage 1962, Lavigne & Holland 1969, Dennis & Lavigne 1975, O'Neill & Kemp 1990, O'Neill in press). Foraging *Stenopogon* make short flights in pursuit of prey from perches on or near the ground and, as a group, prey on a variety of insects. Local populations tend to take a relatively narrow range of prey, but differences among species and populations of *Stenopogon* may be due to spatial and temporal variation in the abundance of potential prey, rather than to variation in prey preference (Powell & Stage 1962, Dennis & Lavigne 1975).

Stenopogon inquinatus Loew is a large species, 20 to 37 mm in length (Dennis & Lavigne 1975), that is widely distributed in North America (Wilcox 1971). Here, we report observations on prey use of *S. inquinatus* in Montana that supplement earlier studies from Wyoming (Dennis & Lavigne 1975) and provide evidence that prey use in this species reflects local insect abundance.

METHODS

Stenopogon inquinatus was studied at two sites, 14 km S of Three Forks and 5 km NE of Logan, Gallatin County, Montana, during the summers 1987–1990. The species was typically present from early June through early August and was easy to distinguish from other asilid species because of its large size. The sites are classified within the *Stipa comata* Trinius & Ruprecht/*Bouteloua gracilis* (Humboldt et al.) Lagasca y Segura ex. Steudel habitat type (Kemp et al. 1990). Prey and observations of predation events were sampled ad libitum. Body lengths of prey and head widths of robber flies were measured to the nearest 0.1 mm, using a micrometer accurate to 0.05 mm.

RESULTS

Foraging behavior for *S. inquinatus* followed the patterns observed by Dennis & Lavigne (1975) in Wyoming. Foraging flies perched on the soil surface or on plants up to 1 m in height and pursued insects flying within about 1 m of the perch. The 170 prey observed at our site included members of five orders, 16 families, and at least 21 species of insects.

The prey specimens that we collected were identified as (numbers of specimens are in parentheses): Hemiptera: Coreidae, *Chelinidea vittiger* Uhler (1); Pentatomidae, *Chlorochroa* sp. (2); Reduviidae, *Apiomerus* sp. (1); Coleoptera: Scarabaeidae, *Onthophagus nuchicornis* (L.) (1), *Aphodius fossor* L. (12), *Dichelonyx* sp. (1); Cicindellidae, *Cicindella punctata* Olivier (1), *Cicindella purpurea* Casey (1), Meloidae, *Epicauta* sp. (1); Lepidoptera: Noctuidae (2); Pyralidae (2); Diptera: Tipulidae (1), Calliphoridae (1); Stratiomyidae (1); Tabanidae (1); Asilidae, *Efferia staminea* (Williston) (13), *Megaphorus willistoni* (Williston) (1), *Machimus occidentalis* (Hine) (2), *Stenopogon inquinatus* (11); Hymenoptera: Formicidae, *Formica subpolita* Mayr (55 alates), *Formica* sp. (4 alates); Halictidae (2), Apidae, *Apis mellifera* (12). Forty-one other prey were identified in the field, but not collected: one *Efferia staminea*, one *Machimus occidentalis*, and 39 *Formica* alates.

The 129 prey collected had a mean length of 12.6 mm (SE = 0.50). Although the *S. inquinatus* collected at this site varied widely in body size (i.e., from 150 to 320 mg wet mass, O'Neill in press), there was no correlation between robber fly head width and prey body length for the 83 pairs for which both values were known ($r = 0.06$, $P = 0.59$). However, some constraints from predator size are evident. There was a significant correlation between predator head width and prey body length when only the largest prey for each predator size class (i.e., 0.1 mm increment) was used in the analysis ($r = 0.61$, $n = 11$, $P = 0.04$). Furthermore, all of the asilids taken as prey by *S. inquinatus* were smaller than the predator (O'Neill in press).

Although *S. inquinatus* had a relatively broad diet breadth, the type of prey used reflected local abundance of insects. For example, 93% of the prey ($n = 70$) collected on 10 days within 5 m of active mating swarms of the ant *Formica subpolita* were winged ants. On eight occasions, we observed *S. inquinatus* fly into swarms of *F. subpolita* on and above *Rhus trilobata* Nuttall and capture an ant. We also collected prey before and after *Formica* swarms on the same 10 days and on six other days when swarms did not appear (but during weeks when swarms appeared on other days). In combined records for these nonswarm periods, only 25% of the prey were winged *Formica* ($n = 28$, $\chi^2_1 = 40.2$, $P < 0.0001$).

By switching to winged *Formica subpolita* during swarms, *S. inquinatus* appeared to have a greater frequency of successful foraging flights. On 4 Jul 1990, 17 of the 20 *S. inquinatus* observed during ant swarms had prey, all but one of which were winged *Formica*. Four days later at the same location, when the ants were not swarming, only one of 55 *S. inquinatus* observed had prey ($\chi^2_1 = 31.71$, $P < 0.0001$). By taking *Formica*, they used smaller prey than at other times. The mean length of winged *Formica* prey was 9.1 mm (SE = 0.11, $n = 59$), although that of all other prey was 15.5 mm (SE = 0.76, $n = 70$; Mann-Whitney test, $P < 0.0001$). There was a limit to which *S. inquinatus* would switch to locally abundant insects. They did not prey upon winged *Leptothorax* sp. (Hymenoptera: Formic-

idae) that swarmed at the same location as the *F. subpolita* on several days in 1988. This ant, which ranged in length from 2.2 to 4.4 mm (\bar{x} = 3.1 mm, SE = 0.23, n = 13), was well below the size range (6.6 to 29.5 mm) of prey used by *S. inquinatus*.

Other examples of site-specific prey use are evident in the prey records. Most honey bee (*Apis mellifera*) prey were collected at patches of leafy spurge (*Euphorbia esula* L.) and Snowberry (*Symphoricarpos* spp.) on which the bees were foraging. There was an apiary about 1 km E of the study site. The presence of cattle in the area may account for dung beetles (Scarabaeidae) being commonly taken as prey on open range.

DISCUSSION

Stenopogon inquinatus, in the Montana population that we observed, used a great variety of insects as prey. However, we found site-specific prey use near ant swarms and flowers. Increased predation on alate ants near mating swarms was also observed in the robber flies *Heteropogon wilcoxi* (James) (Lavigne & Holland 1969) and *Efferia staminea* (Williston) (unpublished data). Site-specific predation by *Stenopogon* has also been observed in studies conducted near apiaries, where 68% of the prey of *S. inquinatus* (Dennis & Lavigne 1975: Riverton, Wyoming prey samples) and 89% prey of *S. rufibarbis* Bromley (Cole 1958) were honey bees. Bromley (1942, 1948) also documents that honey bees are common components of robber fly prey records near flowers and apiaries, but does not compare these to records in other locations. Powell & Stage (1962) noted a difference in prey types of *S. engelhardti* Bromley between dry and moist habitats, with prey records in the latter being dominated by *Tipula coloradensis* (Doane) (Diptera: Tipulidae).

Given such site specificity, it is perhaps surprising that our prey records and those from Wyoming (Dennis & Lavigne 1975) are similar. Honey bees, winged ants, scarab beetles, and robber flies comprised 82% of the prey in Wyoming and 90% in Montana, although our value may be somewhat inflated due to our frequent observations near ant swarms. The Wyoming prey records do not include Hemiptera, but do include insects from two orders, Homoptera and Orthoptera, not found in our samples. However, these orders comprised just a small proportion of all prey in both our samples and those of Dennis and Lavigne. The size range of prey from the Wyoming populations (Dennis & Lavigne 1975: range = 5.0 to 29.5 mm, \bar{x} = 14.5 mm, n = 127) was also generally similar to that at our site (range = 6.6 to 29.5 mm, \bar{x} = 12.5 mm). The correspondence of prey records between areas is probably a reflection of similar grassland insect communities at the two sites.

The prey records presented cannot be used to draw strong conclusions regarding prey preference in an opportunist such as *S. inquinatus*. Simple lists of prey, even from a relatively restricted array of habitats, are liable to reflect several unrelated correlates of prey use. The contents of prey records are not only a function of local insect abundance, but of variation in visibility and catchability among prey species, as well as evolved preferences of robber flies for nutritionally superior or non-toxic insects (Shelly 1984). Our observations and other published reports on *Stenopogon* suggest that both local abundance and catchability (as influenced by size and flight speed) influence prey use. Slow flying insects that are probably easy

to capture are common in *Stenopogon* prey records (e.g., the use of alate *Formica* by *S. inquinatus* and crane flies by *S. engelhardti*, Powell & Stage 1962). However, the flies also include several strong flying species in their diets, such as honey bees and robber flies. Although honey bees are strong fliers, their tendency to hover and approach flowers slowly probably makes them susceptible to robber flies while foraging. In all cases of *S. inquinatus* predation on robber flies, the predator was larger than its prey, suggesting that predator size constrains its ability to take relatively formidable and strong flying prey (O'Neill in press). Thus, the upper limit of *S. inquinatus* prey size (represented by conspecifics) is apparently determined by catchability. The lower limit may be defined by the lower visibility or perceived unprofitability of small insects, such as *Leptothorax* alates that may be locally abundant, but which do not appear in prey records.

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